

NATURAL HISTORY OF THE CHRYSOMELID
CHRYSOPHTHARTA DEBILIS
(COLEOPTERA:CHRYSOMELIDAE)
IN SOUTHWESTERN AUSTRALIA

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ABSTRACT

The life history characteristics of the paropsine beetle *Chrysophtharta debilis* were investigated at several sites in southwestern Australia, and in the laboratory. Whilst the species has a high reproductive potential, natural enemies exert a significant dampening effect. It is recommended that studies of the ecological requirements of the natural enemies be a priority.

INTRODUCTION

Paropsine beetles (Coleoptera: Chrysomelidae: Paropsini) are commonly encountered insects in eucalypt woodlands and forests in Australia. They are active mainly from spring until early winter, and in southeastern Australia some species cause die-back and death to eucalypts (Carne 1966, Greaves 1966).

In southwestern Australia, *Chrysophtharta debilis* is one of the most abundant paropsines and is found either alone or in association with other species of *Paropsis* or *Chrysophtharta* on numerous eucalypt species, especially small trees or coppice (Hall, unpubl.).

Despite its abundance the only published information of this species is a study of its host preferences (Hall 1992). The present paper describes an investigation of the natural history of *Chrysophtharta debilis*, selected as representative of other species of *Chrysophtharta* in southwestern Australia with similar behaviour, distribution and host preferences (Hall pers. obs.)

METHODS

Study sites

The field sites where intensive studies were made were:

(1) Site 1 – a block of over 100 *Eu-*

calyptus rudis, 2–3 m high at Wembley, 10 km W of Perth GPO on coastal sand.

- (2) Site 2 – a block of 50 mixed *E. rudis* and *E. wandoo* at Helena Valley, 20 km E of Perth GPO on lateritic loam.

These sites receive an annual average rainfall of 900–1000 mm (Bureau of Meteorology, Western Australia). Site 1 was formerly vegetated by mixed proteaceous and eucalypt woodland whilst Site 2 would have consisted of mixed Jarrah (*E. marginata*) and Marri (*E. calophylla*) forest on the slopes with Flooded Gum (*E. rudis*) along the drainage lines.

Less detailed phenological studies were made opportunistically at five other study sites. At these sites the emphasis was on studies of oviposition and mortality of *C. debilis* populations, and to verify the observations from Sites 1 and 2.

Laboratory rearing

Chrysophtharta debilis is easily reared in the laboratory, if provided with suitable foliage for oviposition and larval food, and the prepupal, pupal and teneral adult stages are protected from desiccation. The rearing containers used were transparent plastic boxes 17 x 11 x 5 cm, provided with lids having 3 cm holes covered with fine mesh. A 3 x 1.5 cm glass vial supplied water for a shoot of *E. rudis* foliage in the box. When fully-fed the fourth-instar larvae dropped to the floor, from where they were collected into petri dishes lined with filter paper. A maximum of 10 larvae were

placed into each petri dish because preliminary observations showed that higher densities resulted in disturbance to individuals and delayed pupation.

RESULTS

Geographical distribution, host range and habitat

Chrysophtharta debilis feeds on many species of eucalypts and is widespread in southwestern Australia, the author having collected it from the west coast at Perth to the south coast near the Stirling Range and as far east as Kellerberrin. In this study the eucalypts most commonly observed with *C. debilis* were *Eucalyptus rudis*, *E. wandoo*, *E. diversicolor* and *E. gomphocephala*. *C. debilis* was abundant only on young trees or on coppice growth, both in woodland and disturbed sclerophyll forest, and roadside verge vegetation. Mature trees never supported numbers of the insect sufficient to cause damage.

Recognition of the species

Adult *C. debilis* are 6–8 mm in length with the head and pronotum creamy yellow. The elytra are fawn; northern populations have green, purple and gold zones on the elytra while southern populations have the green zones replaced with red pigment. The sexes are similar in appearance, but males are generally smaller than females. The ventral wall of the abdomen is semi-transparent, and in the males the orange-red testes are readily visible.

The larvae of *C. debilis* are not easily distinguished from other *Chrysophtharta* species. Newly emerged larvae are black, and the subsequent three instars become progressively lighter in colour. Third and fourth instar larvae have a dark brown head capsule, yellow body and a prominent black dorsal line.

Life cycle

Flight activity and feeding by the adults begins in August or September, shortly after the production of new foliage by the host eucalypts. After 5–10 days of feeding, the females lay batches of 2, 3 or 4 eggs on soft, but fully expanded, terminal leaves. Each female can lay up to 10 eggs each day and 350 batches of eggs during a period of 3–4 months, so that various stages of the insect may occur simultaneously.

In the laboratory the larvae hatch from the eggs after 6.1 ± 4.9 days ($\bar{X} \pm \text{SD}$), and are highly gregarious at this stage. As the larvae approach maturity, 16–18 days after hatching, they become less gregarious and roam semi-independently over the foliage before finally dropping to the ground. There they burrow individually into the litter and soil and form cells up to 4 cm below the surface. Pupation occurs after 6 days, and adults emerge after a further 12 days. Females are able to oviposit within 10 days of emergence.

Of those adults which emerge in late summer, a small proportion mature and lay eggs in autumn. Their offspring usually die because egg parasites attack many egg clusters and newly emerged

larvae starve because they are unable to feed on the hardened foliage. Some larvae also succumb to avian and arthropod predators. However, the majority of adults enter a form of diapause; they feed voraciously for several weeks and store large amounts of fat. Such adults rest under loose bark or between closely adjacent leaves. On warmer days some adults bask on nearby leaves, but neither feeding or mating was observed. By the following spring when the fat has been exhausted, they resume feeding which is followed by sexual maturation, mating and oviposition.

Behaviour - adults

In spring and summer adults fly when the ambient temperature rises above 20°C, and search over and among foliage before settling on terminal shoots. They feed on the leaf margins, producing the characteristic scalloped appearance seen also with *Paropsis atomaria* (Cumpston 1939, Carne 1966) and other Western Australian paropsines (Hall unpubl.). Mating occurs frequently before the first egg batch is laid and then less frequently as subsequent batches are matured. During winter, or when temperatures fall below 15°C, some adults move from their roosting sites and remain motionless for long periods on leaves exposed to sunshine. At all other times the adults secrete themselves in the folds of distorted leaves or between closely adjacent leaves.

Immediately prior to oviposition the female alights on the chosen leaf and bites a small piece from

the margin. The female then moves to the centre of the leaf and in a backwards fashion lowers her ovipositor to the leaf surface. The egg batches are arranged in ribbons with each egg being cemented to the next along its long axis. The laying of an egg batch occupies the female for 10–30 minutes, after which she resumes feeding. Successive egg batches are laid within one hour of the previous batch, but a maximum of three batches are laid each day.

Reproductive capacity

Fecundity was investigated by caging 20 pairs of adults in separate containers, and recording the number of egg batches and the total number of eggs laid by each female. If the accompanying male died, it was replaced with a mature specimen.

At room temperatures of 19–21°C females were able to live for six months and the last egg was laid 170 days after the first. Under the same conditions males lived for a maximum of 134 days.

The mean period elapsing between laying successive egg batches was 47 ± 10 minutes ($\bar{X} \pm \text{SD}$), but each female could only lay a maximum of three batches each day (mean of 3.2 eggs per batch). The mean number of batches laid per female throughout its life was 450 (range 200 – 560). On these figures the potential reproductive capacity of *C. debilis* under favourable conditions was over 1400 eggs.

Behaviour – larvae

Newly emerged larvae feed on the

remains of their egg shells, before moving together to the margin of a terminal leaf and commencing feeding. Each leaf is consumed before the colony moves to another leaf. As the larvae grow, individuals from different colonies meet and coalesce into larger groups.

During periods when the larvae are not feeding they form the characteristic pattern with the heads of the larvae facing the centre of a circle, similar to the pattern observed with *P. atomaria* and other paropsines (Cumpston 1939, Carne 1966). At such times moulting occurs, and freshly moulted individuals harden before re-commencing to feed. Final instar larvae become more solitary and do not appear to form aggregations.

Duration of immature stages

The duration of the immature stages was determined by taking egg batches no more than 12 hours old from laboratory cultures, and maintaining them at room temperatures. The ovipositing females and larvae were supplied with foliage taken from *E. rudis*; demonstrated previously to be the preferred host of *C. debilis* (Hall 1992). The results are shown in Table 1.

Table 1. Mean duration ($\bar{X} \pm \text{SD}$) (in days) of the immature stages of *C. debilis* kept in the laboratory at room temperature (range of 19 – 21°C). Each stage was represented by 100 individuals.

Eggs	6.1 ± 4.9
Larvae	16.3 ± 2.6
Prepupae	6.0 ± 1.7
Pupae	11.9 ± 2.4

Field observations revealed that

the duration of the immature stages declined with increased ambient temperatures above 30°C, but mortality rose sharply. When field temperatures averaged 20°C, eggs hatched after 12 days. However at temperatures below 10°C, larvae hatched from eggs after an average of 24 days, but the larvae failed to establish feeding sites and died from starvation.

Natural enemies

In order to determine the fate of immature stages in the field, 100 egg clusters and 100 larval aggregations were individually labelled during the peak of the season and monitored until either the animals were dead or had dropped to the ground in readiness for pupation. To determine the potential survival of these stages free of the natural enemies similar numbers of egg masses and larval aggregations were established concurrently in the laboratory. The results are presented in Table 2.

Table 2. Percentage of eggs and larvae of *C. debilis* remaining alive in the field compared with control stock in the laboratory.

Days	Field					Lab.
	1	3	5	7	10	
Eggs						
% alive	100	96	92	84	50	98
Larvae						
% alive	59	17	17	10	7	90

The data in Table 2 suggest that natural enemies of *C. debilis* were very effective in reducing the population. Only 50% of eggs were available to hatch because of the observed effects of leaf-gleaning birds, spiders and predatory

bugs. This compares with 98% survival of eggs in the laboratory. The impact of egg parasitoids such as *Enoggera* spp. further lowers egg survival in the field. In an unpublished study, Tribe (pers. comm.) found that up to 50% of egg masses were parasitised by this wasp.

Larval populations were very susceptible to avian predators, such as the Rufous Whistler which was observed consuming whole aggregations, and entomophagous predators such as assassin bugs (Hemiptera:Reduviidae) which were observed predating young larvae. In addition to the larval predators, tachinid flies (Diptera:Tachinidae) parasitised up to 80% of individuals within some larval aggregations. Once a paropsine larva had been parasitised by a tachinid its behaviour changed. The larva became sluggish, and often removed itself from its companions. If the larva was not fully mature, it thus became more vulnerable to predators, but parasitised fourth-instar larvae often ceased feeding prematurely and dropped to the ground. When the *C. debilis* larva had formed its pupal cell this appeared to be the cue for the tachinid larva to consume its host. The fly pupated within the mummified remains of its host before emerging as a teneral adult.

DISCUSSION

The paropsine *Chrysophtharta debilis* is widespread and seasonally abundant in southwestern Australian woodlands and forests. It does not cause significant dam-

age to commercial tree species, even though it has the potential to do so. This study has shown that adults have a high, but unrealised, reproductive potential, and it is speculated that the impact of natural enemies on the immature stages is the mechanism of control.

Paropsines such as *Paropsis* and *Chrysophtharta* species in eastern Australia are known to cause significant damage to eucalypt regrowth and plantations (Carne 1966, Greaves 1966, deLittle pers. comm.) when they are little affected by natural enemies and *C. debilis* has been shown in this study (Table 2) to have the capacity to produce large numbers of viable progeny in the absence of natural enemies.

Whilst Western Australia currently has the fauna capable of containing *C. debilis*, any silvicultural practises which detrimentally impacts on this fauna could, in turn, have a releasing effect on the paropsine. Since little is known of the natural history of

the various natural enemies, any impact may not be known before significant damage by paropsines is noticed. Data on the ecological requirements of selected species of natural enemies should be considered a priority.

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